# Underlying reasons for different learning approaches in statistics in Italy

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## Abstract

As well documented in different educational contexts, psychology students are not primarily interested in statistics, they dislike anything mathematical, have low self-efficacy and a negative attitude toward statistics, they experience stress and anxiety when dealing with the subject. As a consequence they have a poor performance at the final exam, and they sometime did not pass it. In order to solve the problems encountered by psychology students in statistics and to promote their achievement, the relevance of learning approach to the study of statistics was investigated.
The Italian version of the Approaches and Study Skills Inventory for Students (ASSIST) was used to gain insight about learning approach characteristics that might influence psychology students' achievement in introductory statistics courses. The aim of the present study is twofold. First, to provide evidence of psychometric properties of the scale. Second, to investigated if students' learning approach could predict the achievement in statistics.
Participants consisted of 530 psychology students attending introductory statistics courses. Concerning the psychometric properties of the Italian version of the ASSIST, exploratory factor analyses revealed that the scale has a three-factor structure (Deep, Strategic and Surface subscales) consistent with the original version. Cronbach's alphas for the three scales indicated high reliability. The analysis reveals that students have significantly higher scores on the Deep and Strategic scales compared to the Surface scales. Achievement was measured using the final exam grade. By and large, results showed that achievement was positively related to the strategic approach, i.e., students whose interest in content is driven by assessment demands and they use whatever learning strategy will maximize their chances of success. Due to the course characteristics (a compulsory course at the first year) the strategic approach turn to be the more suitable. Findings are discussed by analyzing the necessity to increase a deep approach to the study of statistics as well as the necessity to decrease the surface approach.

Keywords: Statistics education; Psychology students; approach to learning; achievement.

## 1. Introduction

As well documented in different educational contexts (for a review, Ziefler et al., 2008), many students find it difficult to grasp statistical concepts, and it seems especially true for students attending graduate programs that are traditionally qualitative, as degrees in Psychology. Overall, psychology students are not primarily interested in statistics, they dislike anything mathematical, have low self-efficacy and negative attitudes toward statistics (e.g., Dempster and Mc Corry, 2009), and they experience anxiety when dealing with the subject (e.g., Onwuegbuzie, 2003). For all these reasons, teaching statistics with psychology students, i.e. with students who are not primarily interested in statistics, produces in difficulties (Wiberg, 2009) since they have a poor performance at the final exam, and they sometime did not pass it. Because statistics is a compulsory course in psychology degrees, these failing grades may cause students to abandon their academic and professional aspirations, contributing to the drop-out rate for these university programs.

In order to solve the problems encountered by psychology students in statistics and to promote their achievement, several researches have focused on the identification of models to explain the underlying mechanism of statistics achievement including several variables as attitudes, anxiety, self efficacy, aptitude and skills (e.g., Chiesi and Primi, 2010; Onwuegbuzie, 2003; Tremblay, Gardner, and Heipel, 2000). However, to the best of our knowledge, the relevance of psychology students' learning approach to the study of statistics was not investigated yet.

The approaches to learning paradigm is one of the most widely used frameworks for understanding how students go about learning in higher education (Ramburuth and Mladenovic, 2004; Tight, 2003) and states that the quality of student learning outcomes is influenced by students' approaches to learning, defined as deep, strategic and surface. Starting from these premises, the aim of the paper was two-fold. First, we investigated the psychometric properties of the Italian version of the *Approaches and Study Skills Inventory for Students* (ASSIST; Tait, Entwistle, and McCune, 1998), one of the most widely used tools to measure learning approaches. In particular, a. the factorial structure was tested, b. measures of internal consistency were provided, c. validity was investigated referring to self-efficacy and attitude toward statistics as related constructs (e.g., Baeten, Kyndt, Struyven, and Dochy, 2010). Second, given the characteristics of context in which the learning occurs (i.e., the unit and assessment characteristics) we aimed at investigating psychology students' approaches to learning statistics and the relationships with the achievement in statistics.

## 2. Method

***Participants*:** Data were collected from 530 psychology students enrolled in an undergraduate introductory statistics course at the University of Florence in Italy (during 2011 and 2012 academic years). Participants' age ranged from 19 to 62 with a mean age of 20.7 years ($SD$ = 3.57), and most of the participants were women (81%). This percentage reflects the gender distribution of the population of psychology students in Italy. All students participated on a voluntary basis after they were given information about the general aim of the investigation (i.e., collecting information in order to improve students' statistics achievement).

***Measures*:** The ASSIST was administered along with the following scales.

*Prerequisiti di Matematica per la Psicometria (PMP)* The PMP scale (Galli, Chiesi, and Primi, 2011) was developed to measure accurately the mathematics knowledge needed by psychology students enrolling in introductory statistics courses. It was constructed applying the IRT, and its reliability and validity were tested. The contents were defined on the basis of the basic mathematics abilities requested to solve descriptive and inferential statistics problems.

*Survey of Attitudes Toward Statistics (SATS).* The SATS (Schau, Stevens, Dauphine, and Del Vecchio, 1995) provides a multidimensional measure of attitude that includes the perception of statistics in itself and as part of the degree program, as well as affective and cognitive components. The Italian version of SATS was validated through confirmatory factor analysis, and good indices for both reliability and validity were obtained (Chiesi and Primi, 2009). The SATS contains 28 Likert-type items using a 7-point scale ranging from *strongly disagree* to *strongly agree*. The SATS assesses four Attitudes components: *Affect* (6 items) measures positive and negative feelings concerning statistics (e.g. "I will feel insecure when I have to do statistics problems" or "I like statistics"); *Cognitive Competence* (6 items) measures students' attitudes about their intellectual knowledge and skills when applied to statistics (e.g. "I can learn statistics" or "I make a lot of math errors in statistics"); *Value* (9 items) measures attitudes about the usefulness, relevance, and worth of statistics in personal and professional life (e.g. "Statistics is worthless" or "Statistical skills will make me more employable"); *Difficulty* (7 items) measures students' attitudes about the difficulty of statistics as a subject (e.g. "Statistics formulas are easy to understand" or "Statistics is a complicated subject").

*Current Statistics Self-Efficacy scale* (CSSE, Finney and Schraw, 2003; Italian version: Chiesi, Primi, and Galli, 2007). The CSSE asks students to express their level of confidence in successfully solving statistics problems (e.g., "Interpret the *p-value* from a statistical procedure"). It contains 14 Likert-type items using a 5-point scale ranging from 1 (*Not at all*) to 5 (*Totally*) confident.

Concerning achievement, we took into account the *Final Examination Grade*. This was assigned through an examination form that was constructed by the course instructors. It consisted of a written task and an oral exam. The written task consisted of six problems – to be solved by paper-and-pencil procedure without the support of a statistics computer package –, and four conceptual open-ended questions (e.g., defining the null hypothesis in hypothesis testing). For the problems, students were given a data matrix (3-4 variables, 10-12 cases) and they had to compute descriptive indices, report data in a two-way table or draw graphs, and choose and apply appropriate statistical tests (identify the null and the alternative hypotheses, decide the level of significance, find the critical value, calculate the value of the test, and make a decision). The mark (ranging from 0 to 30) was considered sufficient starting from 18. Students obtaining 18 or more were admitted to the oral exam. The final grade – derived both from the written and verbal parts – was from 18 to 30 in accordance with the Italian University Grading System.

***Procedure:*** The PMP was completed during the second day of class. The SATS, CSSE, and ASSIST were administered at the middle of the course. Each questionnaire was introduced briefly to the students and instructions for completion were given. Answers were collected in paper-and pencil format and the time needed to complete them ranged from 15 to 30 minutes.

Exam sessions started soon after the end of the course. The written exam was timed (2 hours) and was followed by the oral examination.

## 3. Results

Analyses were conducted on the thirteen ASSIST subscale scores: Seeking Meaning (SM), Relating Ideas (RI), Use of Evidence (UE), Interest in Ideas (II), Organized Studying (OS), Time Management (TM), Alertness to Assessment Demands (AAD), Achieving (A), Monitoring Effectiveness (ME), Lack of Purpose (LP), Unrelated Memorizing (UM), Syllabus-Boundness (SB), Fear of Failure (FF). Univariate distributions of subscales were examined for assessment of normality. Skewness and Kurtosis indices of ranged inside the values of -1 and 1 revealing that the departures from normality were acceptable (Marcoulides & Hershberger, 1997).

Then an exploratory factor analysis was conducted with SPSS 17.0 applying *Principal Axis Factor Estimation*. The Bartlett's test of sphericity ($\chi^2 = 206.66$, $df = 42$, $p < .001$) attested that the data were adequate for the analyses. The number of factors to be extracted was determined by eigenvalues above 1.0 which indicated three latent factors explaining the 45% of the variance. We applied an *Oblimin* Rotation and factor loadings attested that all items saturated highly in the expected factor (Table 1). The Strategic factor correlated positively with the Deep factor (.42) and negatively with the Surface factor (-.35). The correlation between Deep and Surface factors was -.12. Thus, the strategic approach was related both to the deep and the surface approach, whereas the deep and surface approaches were not correlated.

Table 1. *Factor loadings of the items, Eigenvalues and Percentage of Accounted Variance for the two-factors solution.*

| | Strategic | Deep | Surface |
|---|---|---|---|
| **SM** | | .61 | |
| **RI** | | .67 | |
| **UE** | | .60 | |
| **II** | | .60 | |
| **OS** | .74 | | |
| **TM** | .87 | | |
| **AAD** | .30 | | |
| **A** | .62 | | |
| **ME** | .36 | | |
| **LP** | | | .71 |
| **UM** | | | .63 |
| **SB** | | | .53 |
| **FF** | | | .42 |
| **% Variance** | 16.7 | 15.2 | 13.1 |

Concerning the reliability, the internal consistency was measured using Cronbach's Alpha coefficients. The alpha for the Strategic subscale was .85, for the Deep subscale was .78, and for Surface subscale was .80. Those values did not increase if any item was deleted.

To investigate the validity, the relationships between statistics self-efficacy score (CSSE) and attitude towards statistics score (SATS) with the Strategic, Deep, and Surface approach scores were investigated (Table 2).

Table 2. *Correlations attitude towards statistics and statistics self-efficacy with the three learning approaches.*

| | Strategic | Deep | Surface |
|---|---|---|---|
| CSSE | .42** | .25* | -.27** |
| SATS | .33** | .28** | -.51* |

$^{*}p < .05$, $^{**}p < .01$

Scores for each scale were computed dividing each summed score for the number of item of the scale (20 for the Strategic, and 16 for the Deep and Surface). In this way, scores might range from 1 to 5. The Strategic mean score was 3.72 (*SD*= 0.47), the Deep mean score was 3.57 (*SD*= 0.54), and the Surface mean score was 2.50 (*SD*= 0.54).

Concerning achievement, a hierarchical regression analysis was conducted (Table 3). In the first step, mathematical competence (measured with the PMP scale) was used as predictor of the final grade since the significant effect of mathematical competence on achievement has been previously demonstrated (e.g., Chiesi and Primi, 2010; Tremblay et al., 2000). In the second step, the three learning approaches were added as predictors of the final grade.

As expected, mathematical competence was a significant predictor of achievement. Additionally, a significant effect of the strategic approach was found.

Table 3. *Hierarchical regression analyses with mathematical knowledge (entered first) and ASSIST scales as predictors of final grade (criterion variable).*

| Predictors | *β* | *t* | *p* | *R change* | *F change* | *p* |
|---|---|---|---|---|---|---|
| **Step 1:** | | | | | | |
| ***Mathematical Knowledge*** | .38 | 4.74 | <.001 | - | - | - |
| $F(1,130) = 22.50, p < .001$, $R=.38$, $R^2= .15$ | | | | | | |
| **Step 2:** | | | | | | |
| ***Mathematical Knowledge*** | .37 | 4.74 | <.001 | .07 | 3.90 | <.05 |
| ***+ Strategic Approach*** | .21 | 2.34 | <.05 | | | |
| ***Deep Approach*** | .02 | .22 | *ns* | | | |
| ***Surface Approach*** | -.10 | -1.16 | *ns* | | | |
| $F(3,127) = 8.93, p < .001$, $R=.47$, $R^2= .22$ | | | | | | |

## 4. Discussion

The Italian version of the ASSIST showed good psychometric properties and this represents a preliminary step to then investigate Italian students' learning approaches. Psychology students showed higher strategic and the deep approach scores in comparison with the surface approach one. Concerning achievement, results showed that the final grade was positively related to the strategic approach, i.e., students whose interest in content is driven by assessment demands and they use whatever learning strategy will maximize their chances of success, obtained higher final grades. The predictive power of the strategic approach was significant once mathematical competence was taken into account in line with previous studies (e.g., Chiesi and Primi, 2010; Tremblay et al., 2000) attested the relevance of the basic mathematic competence on the achievement of the introductory statistics course. This result was confirmed by the present results that attested the predictive role of mathematical competence and demonstrated the additional importance of the strategic approach to study, i.e., an approach including the importance of organise the time and to distribute the effort to greatest effect, to ensure that the conditions and materials for studying are appropriate, to use previous exam papers to predict questions.

Given the fact that the introductory statistics course is compulsory for Psychology students and that they are prevented to pass the exams of the second year if they do not pass the statistics exam, it is not surprising that the strategic approach - an approach that is by definition strongly related to the goal of passing an exam - appeared to be the more suitable. For the same reasons, a deep approach - consisting in examining new facts and ideas critically, and tying them into existing cognitive structures and making numerous links between ideas as well as linking course content to real life - was not the best predictor of achievement. Finally, students who take a surface approach - tend not to have the primary intention of becoming interested in and of understanding the subject, but rather their motivation tends to be that of jumping through the necessary hoops in order to acquire the grade – adopted an approach not adequate to pass an introductory statistics course.

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